POLICY BRIEF

The Economics of Offsets in a Greenhouse Gas Compliance Market

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Introduction

The option of using emissions offsets in a greenhouse gas (GHG) cap-and-trade policy has generated much discussion, both for and against. In this climate policy context, an offset is a contract between two parties under which one party voluntarily agrees to reduce its emissions (or increase carbon sequestration) in exchange for payment from the other party. The paying party may belong to a capped sector and is thus mandated to reduce its emissions to a certain level, while the selling party operates outside of the cap and thus acts voluntarily in order to receive the compensation.

The basic economic argument that underlies both emissions trading, of which GHG cap-and-trade is an example, and offsets is that allowing regulated actors more flexibility in how they reduce emissions will result in cost savings for any given level of reductions. More specifically, rather than design a policy that designates which parties must undertake which reductions to achieve a collective target, it is more efficient to allow parties to contract among themselves to find who can achieve these reductions at the lowest cost. This logic can be seen in the structure of the best-known climate policy offset program, the Clean Development Mechanism (CDM). Under that arrangement, countries that have agreed to binding GHG reduction commitments under the United Nation's Kyoto Protocol can achieve compliance in one of three ways: by decreasing internal emissions, by trading emissions allowances with other countries facing Kyoto emissions targets, or by obtaining emissions reduction credits generated through offset projects in developing countries not bound by Kyoto targets.

A unique characteristic of GHGs is that they accumulate uniformly across the earth's atmosphere, in contrast to other pollutants that are found in higher concentrations near their sources. As a result, an emission reduction delivers the same benefit no matter where it takes place, thereby allowing the commoditization or fungibility of reductions from different sources. This provides an underlying rationale for emissions trading across sources in general and offset trading in particular, if the latter can resolve certain accounting problems associated with being outside the capped system (e.g., leakage as described below). The GHGs most commonly targeted for regulation are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and man-made fluorinated compounds called hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).

Offset programs may provide other benefits in addition to cost containment for the capped sectors. They can serve as a potential source of economic stimulus by delivering needed resources and efficient technologies to uncapped sectors and economically disadvantaged countries. Also, offsets can produce environmental and social co-benefits through the deployment of less-polluting technologies and the protection of carbon-sequestering ecosystems, such as forests.

There are concerns about offset integrity—concerns about whether offset transactions produce real emission reductions and whether they can be properly quantified—that are critical for both the desired environmental outcome as well as for the success of the offsets market. The issues are that reductions being credited may have occurred anyway (no additionality), that emissions simply shift from the party receiving the credits to other parties not bound by a cap or offset program (leakage), or that some offset activities, e.g., forest carbon sequestration, are at risk of subsequent re-emission (permanence). These worries are legitimate. Therefore, well-crafted protocols need to address them if offsets credits are to be valid and cost-effective sources of emission reductions for compliance markets.

Emission Sources Outside of the Cap

While proposed cap-and-trade policies to address climate change will encompass most economic sectors and thus the majority of GHG emissions, some emitting and sequestering activities will fall outside of the compliance cap. There are economic and political reasons for this situation.

Under the current United Nations Framework Convention on Climate Change (UNFCCC) agreement, developing countries are not subject to quantitative restrictions on emissions. In addition to concern for their fragile economies, developing countries have been also excluded from mandates thus far because of the notion that the developed economies have been the primary sources of historic emissions and should bear the brunt of mandatory reductions first. In capped countries, small businesses may also be exempt since the cost of compliance could be too high for them to remain profitable. Some emission sources, including farms, forests, and individual households, are too dispersed to be monitored cost-effectively with current technology and will likely remain uncapped for the time being.[1] Finally, some sectors may have mobilized sufficient political support to secure exclusion. While not efficient, effective lobbying is a reality of the political system.

Types of Offset Projects

Various types of projects can qualify to generate offset credits. Three basic categories of offset projects are direct emission reductions, indirect emission reductions, and sequestration.[2] Direct emission reductions take place at the site of emissions. Examples include fuel switching from higher- to lower-GHG fuels; the capture and destruction or use of methane at landfills, coal mines, and livestock operations; and the application of idle reduction devices to heavy-duty equipment. Indirect emission reductions projects work by decreasing the demand for existing electricity generation or by lowering the need for additional fossil fuel–generating capacity. These reductions occur off-site and consequently are difficult to measure or to assign ownership to.

Sequestration involves the capture and storage of GHGs, usually CO_2, from the atmosphere or from an anthropogenic activity such as energy generation. Biological sequestration projects are the most common at this time and include afforestation and reforestation, establishment of new grasslands, forest management that augments carbon storage, and changes in agricultural soil management. A special case that falls between biological sequestration and pure emission reduction is avoided deforestation, which entails providing payments to maintain existing forest stands and keep their stored carbon intact and thereby avoid the CO_2 emissions that would result from clearing them.[3] Projects using geological sequestration would corral CO_2 emissions from power plants and transport them to geologic formations underground. Carbon capture and storage (CCS) is considered a key emerging technology to help to decarbonize future fossil fuel–based energy production.[4]

Existing and emerging cap-and-trade programs authorize the use of different offset project types as compliance options. The European Emissions Trading Scheme (EU-ETS), the first large-scale GHG cap-and-trade program, lacks a domestic offset program but permits offset projects certified by the CDM or the Joint Implementation.5 The CDM has over 120 methodologies to calculate potential emissions reductions approved for an assortment of project types. As of June 2009, the majority of CDM projects have been in renewable energy, mostly in hydropower development, with only 5% in agricultural or forestry sectors so far (see Figure 1).6 The Regional Greenhouse Gas Initiative (RGGI) is a recently launched mandatory program to lower GHGs from the electric power sector in ten northeastern U.S. states. It allows the following offset types: methane capture from landfills and from manure; SF6 reductions; afforestation; and end-use efficiency projects that reduce on-site consumption of fuels.

1 Under New Zealand's Emissions Trading Scheme (ETS), forestry will actually be the first sector admitted to the ETS, and agriculture will follow in 2013. Given the relatively large contributions that forestry and agriculture make to the country's overall GHG balance, regulation of those sectors is much more vital to New Zealand's mitigation strategy than to the approach of the U.S. Note that although the scheme passed Parliament in October 2008 under the previous government, it is currently under review by a parliamentary committee set up by the new ruling coalition.

2 Pew Center on Global Climate Change. Fall 2008. Greenhouse Gas Offsets in Cap-and-Trade Program. Congressional Policy Brief Series.

3 Murray et al. 2009. Including International Forest Carbon Incentives in Climate Policy: Understanding the Economics. Report R 09-03, Nicholas Institute for Environmental Policy Solutions, Duke University. http://www.env.duke.edu/institute/carbon.economy.06.09.pdf.

4 Climate Change Policy Partnership. http://www.nicholas.duke.edu/ccpp/ccs_overview.html.

5 Joint Implementation (JI) is a flexibility mechanism under the Kyoto Protocol that allows Annex I countries (i.e., developed countries with emission reduction commitments) to invest in emission reduction projects in other Annex I countries in order to earn mitigation credits that can be used toward their commitment goals.

6 UNEP Risoe CDM/JI Pipeline Analysis and Database. Available at http://cdmpipeline.org/cdm-projects-type.htm.

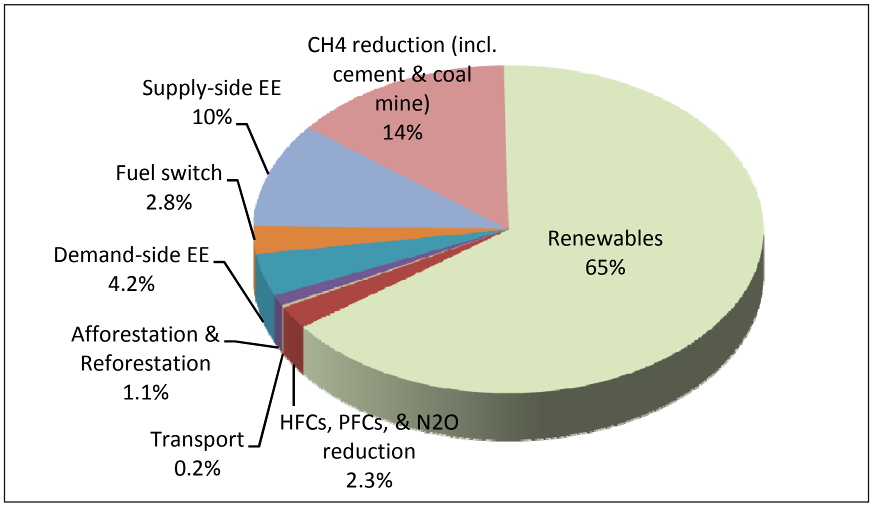
How Offsets Work

In its simplest form, an offset is a contract between a buyer regulated under an emissions cap and a seller who acts voluntarily to reduce emissions. Generally, an offset transaction occurs when the offset seller can cut emissions more cheaply than the offset buyer and the buyer offers payment that exceeds the cost of the emission-mitigating activity.

In Figure 2, we present a simple example of how a cap-and-trade program allowing offsets could function. In a simplified economy with two power plants, a cap is set at 200,000 tons of CO_2e[7] with each capped entity trying to achieve an annual emissions target of 100,000 tons of CO_2e. Each capped entity will determine the most cost-effective means to meet its emissions target, including reducing emissions through investments in better technology, trading of emissions allowances, and/or purchasing offset credits. Plant B weighs its options by comparing its cost of reducing 10,000 tons itself with the cost of purchasing 5,000 tons of allowances offered by Plant A and the cost of purchasing 5,000 tons of offset credits offered by Farm X. If the prices of those options are below Plant B's internal reduction cost, then Plant B will acquire those allowances and credits from the other parties and be permitted to emit 110,000 tons of CO_2e for a net emissions of 100,000 tons of CO_2e (110,000 emission tons minus 5,000 allowance tons minus 5,000 offset tons). Trading allowances and offset credits can allow capped entities to more cost-effectively meet the total cap of 200,000 tons of CO_2e without compromising the environmental integrity of the cap.

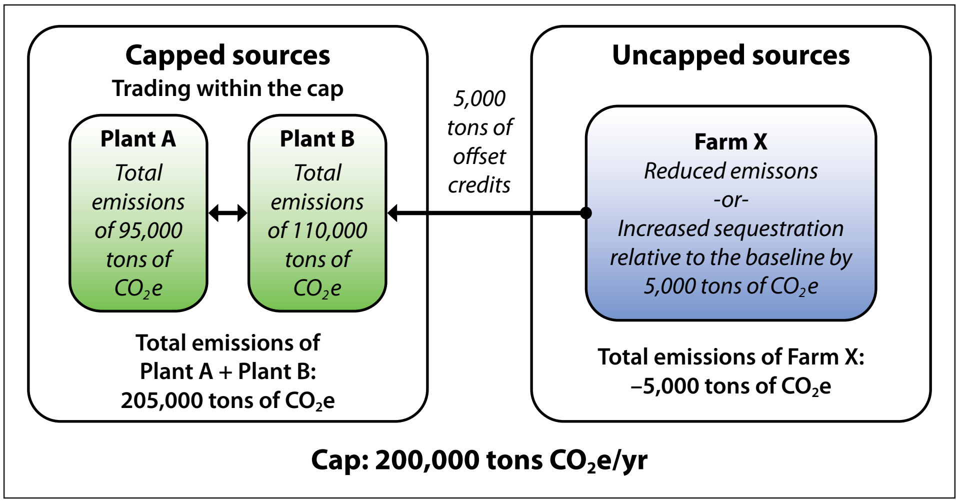
By providing additional sources of emissions credits to a cap-and-trade system, offsets enhance the options of covered entities and can lower the costs of meeting the overall cap. This phenomenon is depicted graphically in Figure 3, with the allowance price/offset cost on the Y-axis and the quantity of GHG abatement on the X-axis. The left and center graphs reflect the capped and uncapped sectors, with MC^C and MC^U as the curves representing the marginal cost of abatement for the capped and uncapped sectors, respectively. The right graph displays the total economy (sum of the capped and uncapped sectors) and the mandatory emissions cap, which is set at abatement level A^T. In Scenario 0, offsets are not permitted and so the allowance price (P_0) is relatively high and marginal cost of total abatement is equal to the marginal cost of abatement for only the capped sector. In Scenario 1 in which offsets can substitute for capped sector reductions, the amount of abatement realized through offsets is A^U_1, and the quantity of abatement among the capped sectors drops from A^C_0 to A^C_1 (an amount equivalent to A^U_1). The use of the less expensive offset credits brings

Figure 1. Proportion of CDM projects in different project categories (Source: UNEP Risoe CDM/JI Pipeline Database).



7 The abbreviation CO_2e stands for carbon dioxide equivalent, a universal metric that standardizes the global warming impact of different greenhouse gases. It is the currency in which emission allowances and offsets are traded in the European Emissions Trading Scheme and would be traded in a U.S. federal cap-and-trade system.

Figure 2. Meeting a cap of 200,000 tons of carbon dioxide equivalents (CO_2e) through intra-cap trading and offsets.



the allowance price/cost down to P_1 and, as a result, the total cap (A^T) is met at a lower cost relative to Scenario 0.

The previous examples demonstrate the economic efficiency associated with including offsets in a cap-and-trade system. Costs of emissions reduction can vary greatly by source as well as by location. While costs for domestic offsets may differ by region, there would be a broader range for costs across countries reflecting greater differences in technology and the relative cost of the factors of production (e.g., labor). The message is that to achieve an emissions target at the lowest cost, a cap-and-trade policy should include as many sources as possible, regardless of sector and location. At the same time, offsets enhance the efficiency of GHG markets by expanding the mitigation options for capped sectors, serving as a means to engage disadvantaged economic sectors and developing countries outside of the cap to expand overall efforts to control GHG emissions. Finally, the opportunity to bank allowances and offset credits affords another form of flexibility—through time—that can help smooth the costs of compliance in future periods.

Concerns have surfaced about offsets "crowding out" or delaying reductions from the capped sectors. The idea is that since the main culprit in GHG production is the energy sector, then the fix should be focused there. From this perspective, the use of offsets could let energy sources off the hook, at least in the short term, by allowing them to avoid or postpone major changes while they can purchase offsets to help meet their compliance obligations.

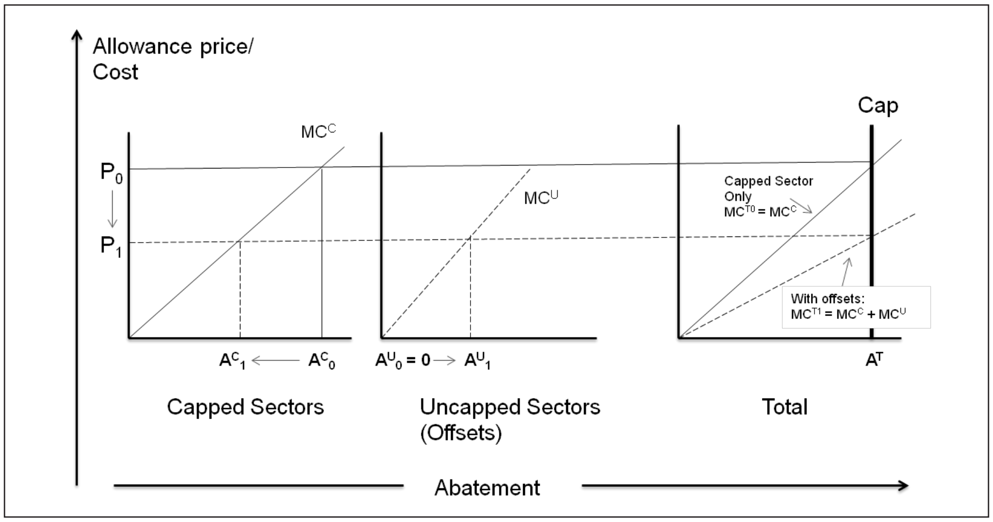
This argument conflicts with the guiding principle of a cap-and-trade system, which is to attain reduction targets in the most inexpensive manner. Using as many sources as possible, including offsets, raises efficiency and lowers costs such that the degree of abatement achieved in each particular sector is immaterial as long as the cap is met. Nevertheless, due to their size, the capped sectors will still be shouldering much of the reductions burden even with a robust offsets program, as the Environmental Protection Agency (EPA) demonstrated in its assessment of the Lieberman-Warner climate bill.[8] In sum, the worry about overreliance on offsets may be misdirected unless reductions (or sequestration) from offsets do not maintain their environmental integrity. We explore this issue in the following section.

Environmental Integrity: Ensuring that Offsets Produce Real Reductions

While offsets can in principle offer a variety of economic, environmental, and social benefits, there are a number of issues critical to ensuring the environmental integrity of an offset program. For offsets markets to be successful and to contribute to emission mitigation goals, there must be confidence that offset reductions do in fact occur, can be properly quantified, and that any re-emission later (reversal) or induced uncontrolled emissions in other locations (leakage) are

8 USEPA Analysis of the Lieberman-Warner Climate Security Act of 2008: S. 2191 in 110th Congress (March 2008). Available at http://www.epa.gov/climatechange/downloads/s2191_EPA_Analysis.pdf.

Figure 3. How offsets lower the costs of meeting the cap.



properly accounted. These specific concerns include the following:

Additionality. Offset projects must produce new "additional" GHG benefits, whether reductions or sequestration, that are above and beyond what would have occurred without the project (i.e., the baseline). The difficulty is that baselines for projects are unobservable counterfactuals, meaning that we cannot tell what would have happened in the absence of a project since implementing the project precludes that future state of affairs. There are a wide range of additionality ests that can be employed to ensure emissions reductions are below (or carbon sequestration is above) the baseline.[9]

Permanence is associated with offsets generated from sequestration of carbon by agricultural and forestry projects (or potentially CCS in the future).[10] Carbon sequestered in trees or agricultural soil is subject to release back to the atmosphere through natural disturbances, such as fires, wind, disease, or pest outbreaks, or via intentional management actions, such as forest clearing or reversing soil management practices from conservation to conventional tillage. Reversal risk of offset projects can be addressed with monitoring and clear, enforceable rules designating liability, but with a cost. Attaching reversal liability to the transaction would impose substantial discounts on the offset credit price received, thereby making projects less attractive to landowners. Another way to deal with liability would be insurance, but this would likewise increase net costs and reduce the value of offsets.

Leakage occurs when an offset project displaces emitting activities to other sources or locations not governed by a cap-and-trade or offset program. As a result, the leaked emissions counteract, at least in part, the project's emissions reductions. Projects involving biological sequestration can be particularly prone to leakage because they compete with land, agricultural, and forest product markets for a fixed land base. In addition, agriculture and forest commodities produced on that land base trade in multi-scale markets, such that market forces may translate changes in the supply of commodities promoted by policies in one location into changes in the demand for and supply of commodities in other, distant locations. For example, a forest management project can generate offsets by sequestering more carbon in trees through longer timber rotations. The quantity of timber supplied to a local or broader-scale market may be reduced, potentially leading to new timber harvest outside of the project area (i.e., leakage) to satisfy unmet demand. Various ways of dealing with leakage exist, including

9 See Olander et al. 2009. Additionality for Offsets in a Federal Cap-and-Trade. Nicholas Institute Policy Brief.
10 Murray, B.C. and L.P. Olander. 2008. Addressing Impermanence Risk and Liability in Agriculture, Land Use Change, and Forest Carbon Projects. Nicholas Institute Policy Brief. Available at http://www.nicholas.duke.edu/institute/offsetseries3.pdf.

project design, discounts, and other accounting adjustments.[11]

Problems related to the three issues discussed may be addressed through offset policy design, following two general approaches—one qualitative, one quantitative.

Quality standards

Each of the problems identified here can be dealt with by imposing standards that protect offset quality. This follows the CDM approach, which restricts the activities eligible for offsets and requires an Executive Board to approve all projects. Accordingly, all CDM projects must meet standards for additionality, address leakage, and require biological sequestration projects to accept temporary payments rather than risk impermanence. These measures were developed to help to allay concerns of those parties skeptical of offset integrity and thus to move the political process forward. So far, results have been mixed. The CDM project approval process has been moving slowly, with the result of constraining the offset credit supply. Although the logjam appears to be loosening, some approved projects have been criticized for generating dubious reductions despite being subject to quality standards. Given both the many challenges inherent with and the substantial benefits possible with offsets, policy development should be adaptive, recognizing that "perfect is the enemy of the good."

Quantitative restrictions

Policymakers have tended to couple quality standards with quantitative restrictions on the use of offsets for compliance. For example, the EU-ETS limits the share of compliance commitments that can be met with offset credits to approximately 10% (with some variation across countries within the EU). By the same token, the recent Waxman-Markey climate bill proposes compliance constraints for the use of domestic and international offsets, limiting each to no more than 1 billion metric tons (t) CO_2e. A potential downside to offset limits would be that they may fill first with the least additional offsets,[12] thus discouraging generation of higher-quality credits through better projects. Another quantitative strategy is to place an explicit discount on the value of offset credits that enter the cap-and-trade system. In the recent Waxman-Markey bill, four tons of CO_2e reductions (or sequestration) are credited for every five tons submitted for certain offsets, which is tantamount to an across-the-board 20% discount for offset credits. This will have the consequence of penalizing good projects to protect against the bad, but may be politically necessary at the beginning of the process. One could reasonably argue that there is no need for restricting offset quantities if the quality of offsets is up to par with capped sector reductions. However, with offsets in their nascent stages, and with some initial problems with CDM noted,[13] it may be difficult to give complete quality assurances at this point. Quantitative restrictions could be a temporary measure in force while offset markets are tested and polished and quality assurance is improved, but they should not be viewed as a substitute for robust quality standards.

Expected Market Impact of Offsets: Findings from Recent Economic Studies

A clearer understanding of the economics of offsets can help guide the decision-making process of policymakers. Several recent economic studies have employed economy-wide modeling efforts to assess the potential impacts of including offsets in a cap-and-trade system. EPA evaluated the Lieberman-Warner Climate Security Act (S. 2191) with two economy-wide models, Intertemporal General Equilibrium Model (IGEM) and Applied Dynamic Analysis of the Global Economy (ADAGE), in spring of 2008.[14] The Lieberman-Warner bill limits offsets, both domestic and international, to each being up to 15% of the overall compliance cap. EPA's analysis used a variety of analytical scenarios, including those with different assumptions regarding the use of offsets in the proposed carbon market system. In the summer of 2008, a similar analysis of the Lieberman-Warner bill was conducted by the Nicholas Institute, RTI International, and OnLocation Inc. using ADAGE and a user-customized version of the National Energy Modeling System (NEMS).

11 Jenkins, W.A., B.C. Murray, and L.P. Olander. 2009. Addressing Leakage in a Greenhouse Gas Mitigation Offsets Program for Forestry and Agriculture. Policy Brief PB 09-03. Nicholas Institute for Environmental Policy Solutions, Duke University. http://www.nicholas.duke.edu/institute/offsetseries4.pdf.

12 Wara M.W. and D.G. Victor 2008. A Realistic Policy on International Carbon Offsets. Program on Energy and Sustainable Development Working Paper #74, Stanford University.

13 U.S. Government Accountability Office, 2008. "International Climate Change Programs: Lessons Learned from the European Union's Emissions Trading Scheme and the Kyoto Protocol's Clean Development Mechanism". GAO-09-151. Available at: http://www.gao.gov/products/GAO-09-151.

14 USEPA Analysis of the Lieberman-Warner Climate Security Act of 2008: S. 2191 in 110th Congress (March 2008). Available at http://www.epa.gov/climatechange/downloads/s2191_EPA_Analysis.pdf.

These findings highlight the possible effects of offsets on allowance prices, the proportion of emissions reductions sourced from offsets, the banking of reductions, and co-benefits, among other issues. Differences in the scope, methods, and assumptions of these studies lead to a somewhat wide range in estimates, but the results are in broad agreement. What follows is a discussion of the key findings from the economic studies.

1. Price effects

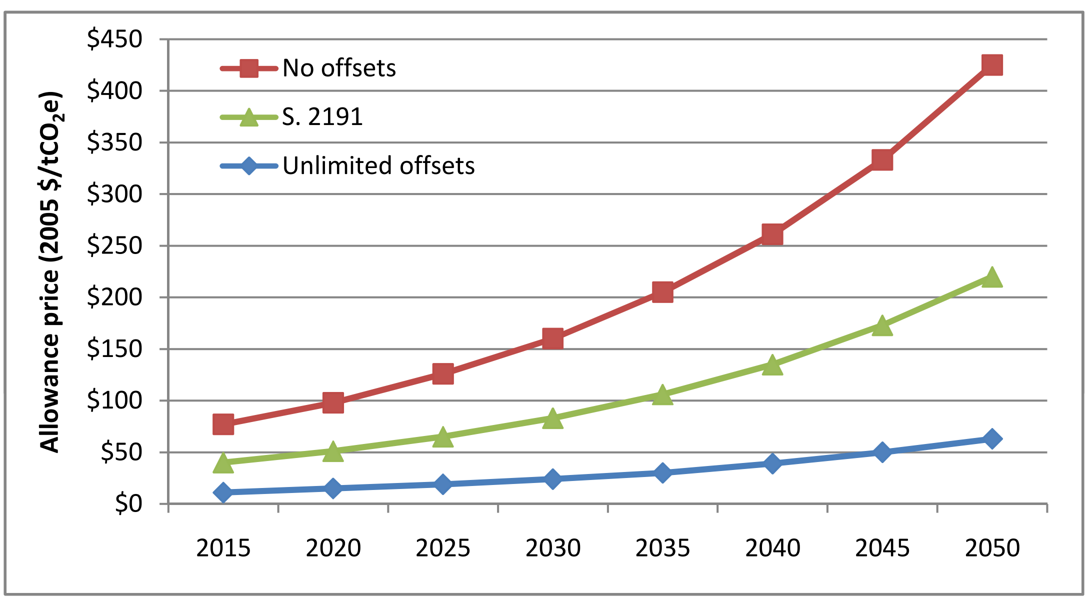
Permitting the use of offsets in a cap-and-trade GHG market can exert substantial influence on allowance prices for a metric ton of CO_2e. Offsets provide entities under the mandatory cap more flexibility to meet their obligations and the potential to furnish emissions reductions at lower cost.

In Figure 4, results from EPA's modeling runs for S. 2191 using the IGEM model demonstrate how the allowance price varies with the use of offsets. For the bill as written (i.e., S. 2191), the central price estimate is$40/t$CO_2$e in 2015, rising at 5% per year to $220/t$CO_2$e in 2050.[15] Prohibiting offsets would raise the 2015 price estimate to $77, approximately 93% higher than the S. 2191 result. At the other end of the spectrum, allowing unlimited offsets lowers the estimated price by 71% ($11 in 2015). The EPA study evaluated some additional cases, which are not shown in Figure 4. When assuming unrestricted use of domestic offsets and a 15% cap on international offsets, allowance prices decrease by 26% relative to the bill as written. Alternatively, constraining domestic offsets to 15% and prohibiting international offsets raises allowance prices by 34% compared to the S. 2191 scenario. Overall, considering various scenarios, the EPA modeling results show that use or restriction of offsets, both domestic and international, exerts a larger impact on allowance prices than the availability of or constraint on key enabling technologies, such as CCS.

2. Share of Abatement and Compliance Obligation

The degree to which offsets may be used in a cap-and-trade system will strongly influence the proportion of total abatement and compliance obligation coming from offset credits. For example, when the use of both domestic and international offsets is unlimited, the EPA analysis finds that 52% of abatement in 2030 and 45% in 2050 will be sourced from international credits.[16] In the case where domestic offsets are unlimited and international ones are restricted to 15% of compliance obligations, 26% of abatement in 2030 and 15% in 2050 comes from domestic offsets.

Figure 4. Allowance prices as affected by different restrictions on offset use in EPA's analysis of Lieberman-Warner bill (S. 2191) (IGEM Model).



15 All prices are assumed to rise at the real discount rate of 5% per year in all scenarios.

16 Abatement here refers to the reduction of actual emissions below the projected baseline or business-as-usual emissions without the policy.

In Figure 5, a Nicholas Institute-RTI International-OnLocation Inc. analysis reveals that changing the offset constraint from a 15% cap to 1 billion tons per year (for domestic and international offsets each) can mean a different distribution of cap obligations attributable to domestic and international offsets. Early on, domestic offsets only account for 2% of compliance obligations for the 1-billion-ton limit case, but this grows to 22% by 2030, easily exceeding the 15% limit that the Lieberman-Warner bill imposed. The domestic offset share starts out low because allowance prices are low in the early years under these scenarios. As prices rise over time, more domestic offsets are produced. International offsets play a major role throughout the period, accounting for 18% to 26% of compliance obligations. By year 2030, domestic and international offsets contribute almost half (48%) of the compliance obligations required by the cap.

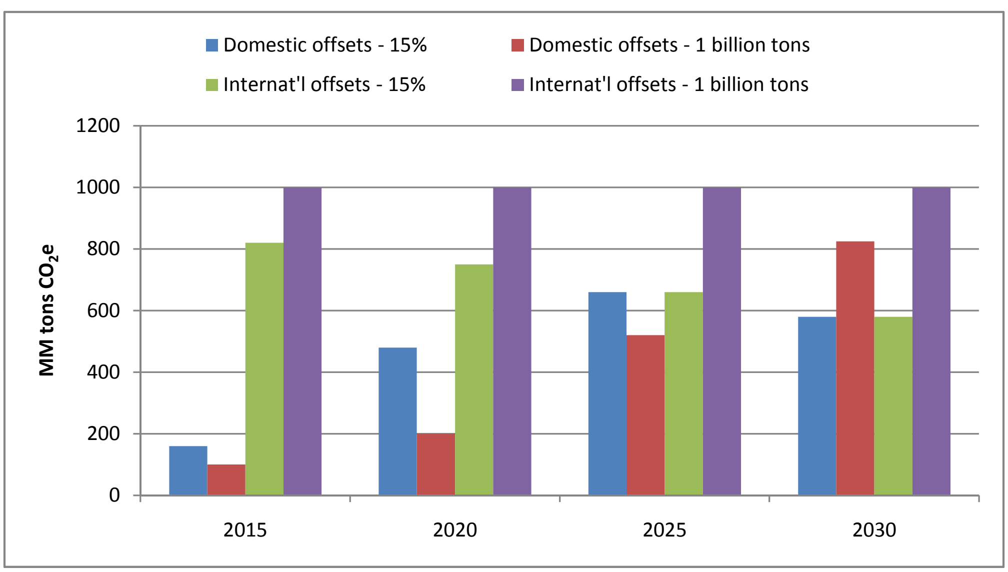
3. Offsets enable emission allowance banking

In the cap-and-trade context, banking is defined as saving credits for future compliance use against a stricter cap. The ability to bank emission allowances provides capped entities with the flexibility to pursue the most cost-effective means of reducing emissions first (which may be offsets), while developing business strategies and adopting technologies that will create reductions later down the line. Banking also rewards early action, including offsets, by furnishing a way to store the value of GHG reductions through time. This makes environmental sense because it leads to emissions reductions being realized sooner than they would otherwise. In addition, banking allowances for later use can help smooth out the costs of compliance over time, mitigating the risk of heavy costs that could burden a capped entity over the short-term. Banking also provides flexibility to offset sellers, allowing them to undertake projects, earn offset credits, and/or sell the credits when it is most advantageous to them. The economic analyses of the Lieberman-Warner bill by EPA and Nicholas Institute et al. referenced above both indicate that procuring offsets early in the program can play a substantial role in the development of an allowance bank, thereby achieving reductions early on while helping to lower costs in the later years of the program.

4. Offset supply functions

For its Lieberman-Warner analysis, the EPA generated offset supply functions separately for domestic and international offsets (Figure 6 and Figure 7). As one would expect, supply expands over the period of 2012–2030 and generally increases with the allowance price. Domestic offsets include uncapped sources plus

Figure 5. Compliance obligations met with domestic and international offsets. Bars indicate the level of GHG mitigation and percentages represent the proportion of the compliance cap, which are met by each offset type. Source: Internal analysis by Nicholas Institute, RTI International, and OnLocation Inc.



biological sequestration. Their supply increases until $40/$tCO_2e$ in the early years and until $50 in 2025 and 2030, indicating that even if prices continue to rise there is a limit to the supply that can be mobilized. Regarding international offsets available to the U.S., perhaps the most important point is that their potential supply is over ten times greater than what can be marshaled domestically. In addition, international offset supply becomes exhausted (i.e., goes vertical) at somewhat higher prices than the domestic supply in years 2012–2020. But the quantity supplied continues to grow with higher prices in 2025 and 2030, indicating much deeper reserves being accessible internationally. Prohibiting or greatly limiting the use of international offsets could hamper cost containment in the U.S. cap-and-trade system and constrain the overall global mitigation that could be achieved.

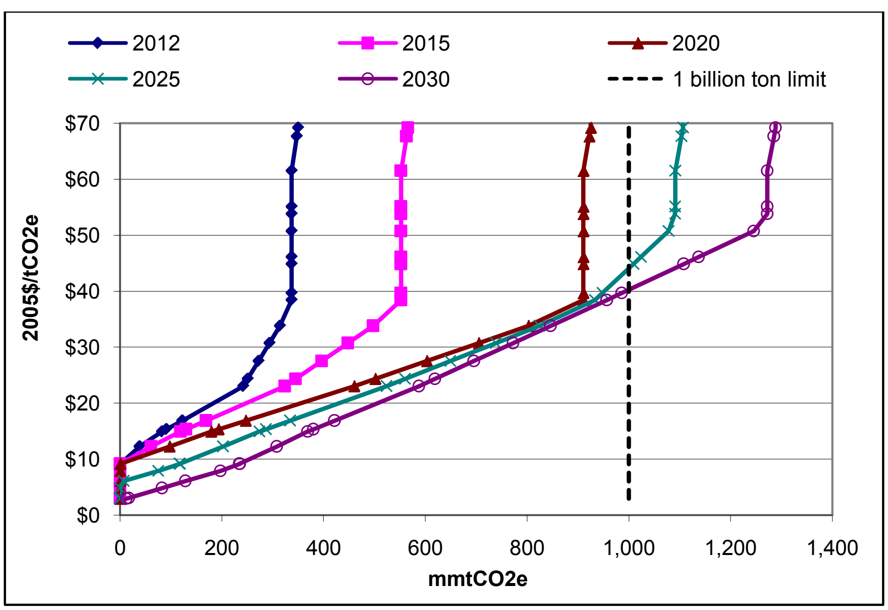
5. Offsets as bridge strategy

Given the serious challenges capped entities may face in finding internal emissions reductions, offsets could effectively function as a "bridge," buying time for the development of enabling technologies that will be essential to delivering reductions in the future. Accordingly, modeling results show that early GHG compliance relies heavily on offsets to meet the cap (Figure 8). International offsets account for a large portion of this compliance initially, constituting about 40% of emissions reductions in 2012. The dependence on international offsets to meet compliance obligations wanes through time as covered emissions and domestic offsets mature. This analysis implies that it may be difficult to satisfy a stringent cap if international offsets are not included as part of the policy structure.

6. Environmental co-benefits

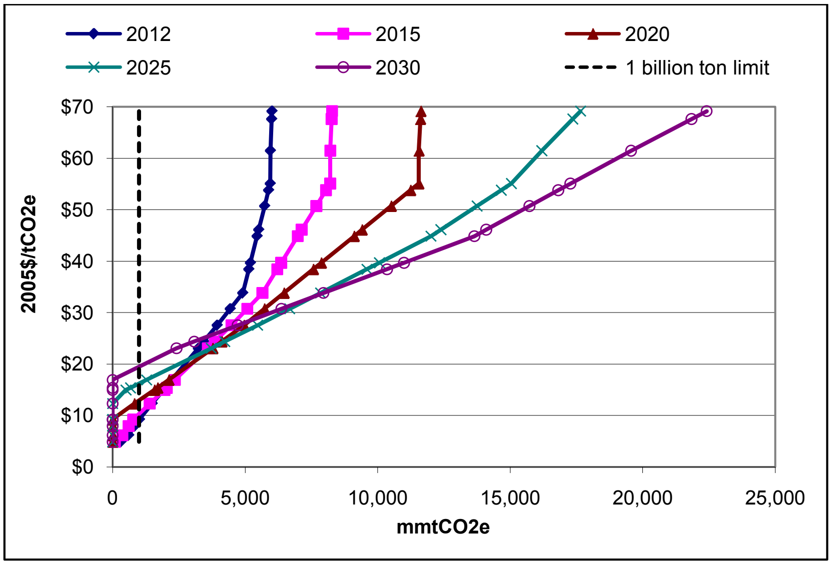
The use of offsets can produce non-GHG environmental co-benefits through the deployment of less-polluting technologies and the protection of ecosystems that sequester carbon. In addition, other GHG mitigation activities, such as afforestation or conservation tillage, will not only generate offset credits, but will also induce broad changes in land use and management practices that can affect air quality, water quality, soil quality, and biodiversity. A 2005 EPA study[17] projected a net gain in U.S. forest area of 5 million to 58 million acres by the year 2055, at carbon prices of $15/$tCO_2e$ and $50/$tCO_2e$ respectively. This predicted land-use shift would lead to substantial reductions in soil erosion as well as in loadings of nutrients nitrogen and phosphorus to the nation's waterways. These nonpoint pollutant loadings decreased in all carbon price scenarios relative to the baseline, with greater reductions corresponding to higher prices. Note that the study results also reported a co-cost, as pesticide loading increases in scenarios with low carbon prices.

Figure 6. Domestic offsets supply function used in EPA's analysis of Lieberman-Warner bill.



17 US EPA 2005. Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture. Report 430-R-05-006.

Figure 7. International offsets available to the U.S.



Another study[18] estimated the water quality co-effects of GHG offset strategies in U.S. agriculture by linking national-level agricultural sector and water quality models. A water quality index (WQI), which accounts for the loading of different pollutants, was used as the metric reflecting water conditions. Under a $6.80/ tCO_2e scenario, the WQI rose nationally by 1.5 index points, equivalent to a 2% gain from its baseline level. Though the levels of water quality improvements varied regionally, all regions experienced benefits with effects being strongest in the Plains states and up and down the Mississippi River Valley. In Figure 9, dark blue illustrates the waterways that have the greatest increase in WQI, while dark red represents waterways undergoing a drop in quality.

There may also be negative tradeoffs between other ecosystem services and carbon sequestration projects. Afforestation with tree plantations can lead to considerable reductions in stream flow, with some streams drying out completely for at least a year, as well as increased occurrence of soil salinization and acidification.[19] However, in some areas, particularly those where crops have replaced forests, afforestation may help to restore water quality and recharge.[20] Local factors, such as soil texture, site history, and the availability and quality of groundwater, play a key role in predicting the full environmental impact of tree plantations and, by extension, the co-benefits or co-costs of proposed sequestration projects.

Finally, natural ecosystems, such as forests and wetlands, can play a key role in adaptation to climate change. Restoring or maintaining these systems will provide humanity a natural insurance policy. They could help maintain the provision of many ecosystem services by acting as buffers to threats, such as drought, flooding, and vector-borne diseases, which could be aggravated by climatic shifts. In this way, offsets can produce the double dividend of cutting GHG emissions and strengthening our adaptive capacity.

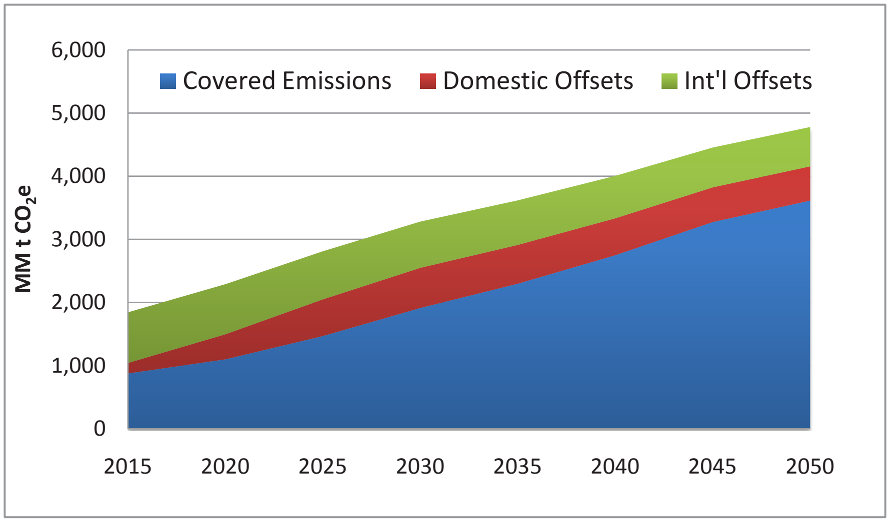
Summary

Permitting offsets in a cap-and-trade policy affords greater flexibility for capped entities to meet their GHG obligations and translates to lower costs in reaching any given level of emissions reduction. The fact that all GHG reductions (increases in sequestration) are equivalent, no matter their source or location, makes the trading of emissions allowances and offsets and the resulting efficiencies possible.

18 Pattanayak et al. 2005. "Water quality co-effects of greenhouse gas (GHG) mitigation in U.S. agriculture" Climatic Change, 71: 341-372.
19 Jackson, R.B. et al. 2005. "Trading Water for Carbon with Biological Carbon Sequestration". Science, 310: 1944-1947.

20 Plantinga A.J and J. Wu. 2003. "Co-benefits from carbon sequestration in forests: Evaluating reductions in agricultural externalities from an afforestation policy in Wisconsin". Land Economics, 79: 74-85.

Figure 8. GHG reductions (in millions of metric tons CO_2e) by type for 2015-2050 period. Source: Internal analysis by Nicholas Institute, RTI International, and OnLocation Inc.

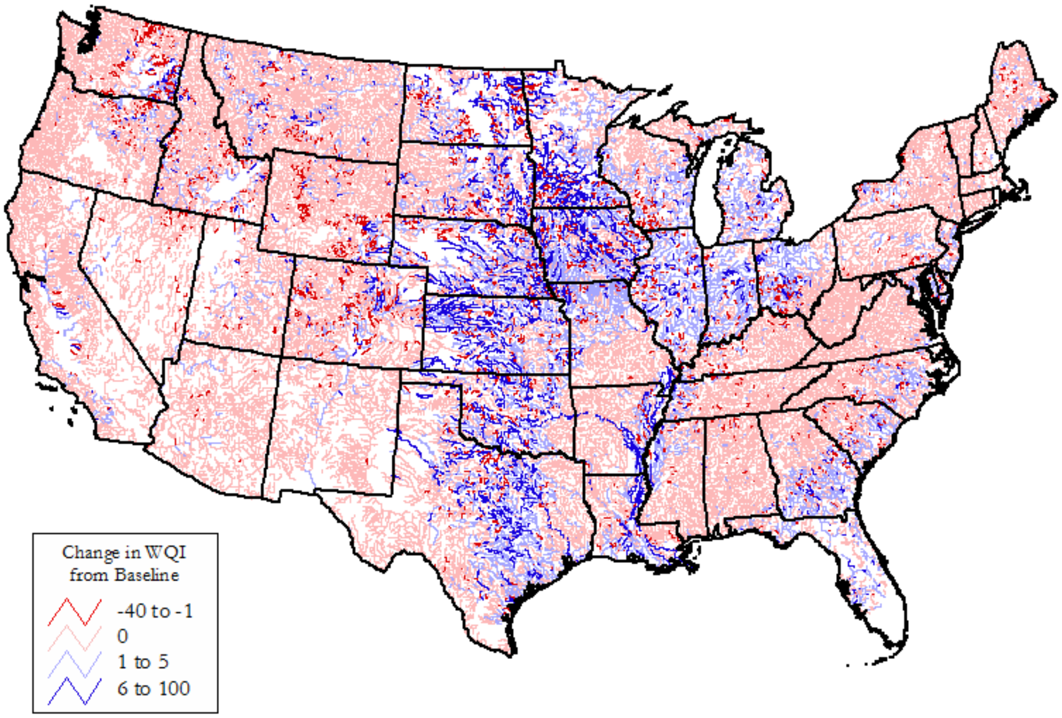


Most of the controversy surrounding offsets stems from two concerns: (1) that offsets will "crowd out" or defer reductions at capped sector sources (e.g., combustion sources in the energy sector) and (2) that they may lack environmental integrity—that is, credits may not reflect real reductions. The former raises concerns because some parties believe that climate is ultimately an energy sector problem requiring energy sector solutions. But if the premise of cap-and-trade is to achieve the target using reductions from as many sources as possible as inexpensively as possible, then sector minimums need not be the goal, as long as the reductions from offsets are real. Therein lies the second issue: integrity. It is important to demonstrate that offsets represent "additional" GHG reductions or sequestration that would not have occurred otherwise, that emissions do not simply leak from a mitigation activity receiving credits to one not covered by a cap-and-trade policy or an offsets program, and that risk of reversal for certain offset project types (i.e., those involving biological sequestration) can be accounted for. The application of qualitative standards, supplemented by temporary use of quantitative restrictions, can help ensure that high-quality offsets that bring genuine reductions enter the system.

Recent economic modeling studies quantify the benefits that offsets could provide. Allowance prices would be substantially lower with offsets, especially when limits on offsets are loosened or removed. Emissions reductions via offsets could constitute a considerable proportion of the total compliance cap, replacing higher-cost reductions from other sectors early on, while eventually being supplanted by the reductions from the capped sectors. In that regard, offsets could function as a bridge strategy, buying time for the development and deployment of key enabling technologies. In addition to climate-related benefits, offsets can help generate non-GHG co-benefits, such as improvements in water, air, and soil quality. Nevertheless, care should be taken to ensure against negative environmental and economic co-effects from improper placement of projects in areas where severe conflicts arise.

Offsets are by no means a panacea. But if appropriate standards can allay potential accounting problems, offsets could act as an efficient complement to a cap-and-trade market, offering greater options, lower costs, and expanded reduction opportunities.

Figure 9. Changes in Water Quality Index (WQI) from Baseline resulting from agricultural management changes under \$6.80/tCO_2e in ca. 2020. Source: Pattanayak et al. 2005.



the Nicholas Institute

The Nicholas Institute for Environmental Policy Solutions at Duke University is a nonpartisan institute founded in 2005 to engage with decision makers in government, the private sector, and the nonprofit community to develop innovative proposals that address critical environmental challenges. The Institute seeks to act as an "honest broker" in policy debates by fostering open, ongoing dialogue between stakeholders on all sides of the issues and by providing decision makers with timely and trustworthy policy-relevant analysis based on academic research. The Institute, working in conjunction with the Nicholas School of the Environment, leverages the broad expertise of Duke University as well as public and private partners nationwide.

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